LATTICE GIRDER SUPPORTING FRAME HAVING STRAIGHT BRACE PARTS

Technical Field

[01] The present invention is directed to a lattice girder supporting frame. In particular, the present invention is directed to a lattice girder supporting frame for tunnel lining, having a plurality of boom members and truss braces welded together to provide a high-load bearing capacity.

[02] This application is based on German Patent Application 100 20 572.0, which is incorporated herein by reference.

Background

[03] Conventional lattice girders are described, for example, in DE 197 11 627 C 2. The lattice girder has three parallel boom members which are connected to each other by V-shaped truss braces. The truss braces are bent at the portion where the truss brace and boom member are connected. The truss braces and boom members are welded together at these portions. A cross-tie is provided to hinder a zip-like failure of this weld.

[04] EP 0073 733 A 1 describes a lattice girder having three parallel boom members which are spatially secured relative to each other by means of internal one-piece bracing elements. These bracing elements have very narrow bending radii which can be used for comparatively thin elements only.

Summary of the Invention

[05] The invention is based on the objective of developing a lattice girder supporting frame and bracing elements for lattice girder supporting frames of the generic types, which - while improving such properties as high stressability of welds, shortening of the unsupported lengths of braces, avoiding of buckling of

braces - allow to make production substantially more cost-effective due to the possibility of compensating manufacturing tolerances.

[06] The present invention has a structure in which the bracing of the lattice girder is arranged so that a higher load bearing capacity is achieved by avoiding bending in the area of the lower booms.

[07] The objectives of the present invention are achieved by a lattice girder supporting frame for tunnel lining which includes upper and lower boom members arranged in parallel relative to each other and forming a triangle, truss braces spatially connecting the upper and lower boom members to each other, wherein each of the truss braces has straight brace parts spaced in a V-shape relative to each other, and each of the straight brace parts are connected to each other at one end via a straight bridge piece, wherein the truss braces are arranged in a symmetrical plane extending laterally from the upper boom member to an axis of the lower boom members. Cross ties extend at right angles relative to the lower boom members, for connecting the lower boom members to each other and the truss braces abut the lower boom members without bending and are welded to the lower boom members.

[08] A bracing element of the present invention includes two brace parts angled relative to each other, wherein one end of each of the brace parts has a curved part and the other end of each of the brace parts is straight The other end of each of the brace parts is adapted to be connected to the lower boom members without bending. A straight brace part connects the brace parts to each other at the curved parts so as to form a truss brace, wherein the straight brace part extends parallel to the upper and lower boom members. Two truss braces are connected to each other via cross-ties so as to form the bracing element, wherein the cross-ties are fixedly secured by a weld to the truss braces, and wherein the cross-ties are adaptable to contact the lower boom members.

Brief Description of the Drawings

[09] The above objects and advantages of the present invention will become more apparent by describing in detail preferred embodiments thereof with reference to the attached drawings in which:

[10] FIG. 1a illustrates a cross-sectional view along line I-I of FIG. 1a;

[11] FIG. 1b illustrates a lateral view of a first embodiment of the lower boom member arrangement;

[12] FIG. 2a illustrates a cross-sectional view along line II-II of FIG. 2b;

[13] FIG. 2b illustrates a lateral view of an alternative embodiment of the lower boom member

[14] FIG. 3a illustrates a cross-sectional view along line III-III of FIG. 3b;

[15] FIG. 3b illustrates a lateral view of the upper boom arrangement;

[16] FIG. 3c illustrates alternative arrangements of FIG. 3a;

[17] FIG. 4a illustrates a cross-sectional view along line IV-IV of FIG. 4b; and

[18] FIG. 4b illustrates another view of the present invention.

Detailed Description of the Invention

[19] Embodiments of the present invention are now described with reference to FIGS. 1a - 4b.

[20] As shown in FIG. 1a and 1b, lower boom members 2, straight brace parts 3 and cross-ties 4 are provided for a lattice girder structure. A welded connection 1 between lower boom member 2 and straight brace part 3, a welded connection 5 between straight brace part 3 and cross-tie 4, and a welded connection 7 between boom member 2 and cross-tie 4, are provided to attach the members together.

[21] The cross-ties 4 are positioned welded to both the straight brace part 3 and the lower boom member 2 wherein the straight brace part abuts the lower boom member 2 at an acute angle (as viewed in FIG. 1b), and the cross-ties 4 are provided inside the acute angle so as to be welded to the lower boom member 2 and the straight brace parts 3.

[22] FIGS. 2a and 2b show another embodiment having a welded connection 6, 7 between straight brace part 3, cross-tie 4, and boom member 2. In this embodiment, the cross tie 4 is disposed between the straight brace part 3 and the lower boom member 2.

[23] As shown in FIG. 3b, two straight brace parts 3 connected by a straight bridge piece 3a form a truss brace 10. The end of the straight brace part 3 has a curved portion which connects to the straight bridge piece 3a (see FIG. 4a), while the other end of the straight brace part 3 is a straight portion.

[24] FIGS. 3a and 3b show the lateral positioning of the truss brace 10 relative to an upper boom member 8. In this embodiment, the upper boom member 8 is relatively thicker than the lower boom members 2. While FIGS. 3a and 3b show that the straight brace parts 3 are provided on opposite sides of the boom member 8, FIG. 3c shows that the upper boom member 8 may be variably positioned with respect to the truss braces 10 by a distance "a". In FIG. 3c, "X" represents a plane passing perpendicularly through the center of the straight bridge piece 3a. Thus, the upper boom member 8 may be variably positioned at X or at X-a or X+a, where a is less than or equal to the radius of the upper boom member 8.

[25] FIGS. 4a and 4b show views of a three-boom lattice girder frame in which a bracing element 11, consisting of the two truss braces 10 and two cross-ties 4, is arranged between the lower and upper boom members 2, 8.

[26] The truss braces 10 in combination with the cross tie 4, allow the bending tolerances of the thicker upper boom member 8 to be compensated by placing the upper boom member 8 between a straight bridge piece 3a of the truss braces 10. As illustrated in FIGS. 3a-3c, the straight bridge piece 3a is connected to the upper boom member 8 at welded connection 9.

[27] Three or four (not shown) boom members 2, 8 arranged in parallel relative to each other and forming a triangle (when viewed in cross-section), are spatially connected to each other, while each of the truss braces 3 is provided with straight brace parts 3 spaced in V-shape relative to each other, which are

connected to each other at one end via the straight bridge 3a. The truss braces 10 are arranged in a symmetrical plane extending laterally from the upper boom member 8 toward the axis of the lower boom member 2, wherein the lower boom members 2 are connected to each other by the cross ties 4 extending at right angles relative to the lower boom members 2.

[28] The advantages of the invention may be summarized as follows. The immersion of the upper boom member 8 between the truss braces 10 at the straight bridge pieces 3a allow several options. On the one hand, the tolerances resulting in the area of the bending radii of the thick upper boom member 8 can be compensated by a difference in position between the boom member and truss braces (see FIG. 3c). On the other hand, the overall lattice girder heights can be modified by X + (a) or X - (a), respectively, by varying the position of the upper boom member 8 and by thus changing the resistance moments while maintaining the geometry of the truss braces 10.

[29] Both possibilities substantially contribute to making production more cost-effective. The straight brace part 3 abutting the lower boom member 2 without bending and the cross tie 4 arranged directly adjacent to it allow to use greater brace cross-sections and a pre-fabrication of the bracing elements 11 in an easy way. The arranged weld 1, 7 including both the abutting straight brace part 3 as well as the cross-tie 4 is sufficiently long to absorb the tensile and compressive forces present at that point. By avoiding bending and by the lateral arrangement of welds 1, 7, the economic efficiency of production can be improved still further.

[30] A fixture is used to weld the truss braces 10 in the desired inclined position to the cross ties 4 at the weld connections 5 so that an inelastic bracing element 11 is produced. Such bracing elements 11 are arranged in series between the boom members 2, 8 and welded to the boom members in a fixture.

[31] The lattice arches for tunnel construction are produced in segments which are combined inside the tunnel to form an arch by connections at the segment ends.

[32] While this invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.